Borderwide Binational Hydrography Methodology

US-Mexico Border Environmental Health Initiative
Internet Map Service
http://borderhealth.cr.usgs.gov
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Background

The objective of the Border Environmental Health Initiative (BEHI) project is to provide geographic data served over the web, which will allow people to examine the ties between the physical environment and public health issues. The BEHI website is currently available on the Internet at: http://borderhealth.cr.usgs.gov. One portion of the data the BEHI is making available for the public to use is the hydrography shared between the United States and Mexico. The geographic display of hydrographic data for the United States and Mexico allows researchers to identify gaps in monitoring networks, ascertain areas of potential contamination or pollution, recognize health concerns connected to the environment, and to potentially discover many other environmental health issues. Hopefully, the identification of these issues will be an incentive for future collaborative work between the United States and Mexico.

Data

The sources of hydrographic data include:

Mexico: Instituto Nacional de Estadística, Geografía, e Informática (INEGI) 1:50,000 scale
Mexico: Instituto Nacional de Estadística, Geografía, e Informática (INEGI) 1:250,000 scale
Mexico: Instituto Nacional de Estadística, Geografía, e Informática (INEGI) 1:1,000,000 scale

U.S.: U.S. Geological Survey National Hydrography Dataset (NHD) 1:24,000 scale
U.S.: U.S. Geological Survey National Hydrography Dataset (NHD) 1:100,000 scale
U.S.: National Atlas of the United States 1:2,000,000 scale
U.S.: North American Atlas 1:10,000,000 scale

The Hydrographic Dataset

Borderwide Non-networked Hydrography

The 1,951 mile shared border between Mexico and the United States encompasses various types of landscapes, ecosystems, and watersheds. Scientists reseaching specific environmental issues may need to examine the processes at either international, regional, or local scales. Therefore the BEHI project created three different hydrography layers at various scales, and used one existing dataset for display of very small scale data (North American Atlas 1:10,000,000 hydrography). Each of the three datasets created for this project merges data from Mexico and the United States into a new dataset.

The first dataset contains INEGI 1:1,000,000 data combined with National Atlas of the United States 1:2,000,000 data. The second dataset contains INEGI 1:250,000 data combined with NHD 1:100,000 data. The third dataset contains local level (1:24,000 NHD and 1:50,000 INEGI) streams where available. Where local level data are not available, medium resolution (1:100,000 and 1:250,000) streams are shown. U.S. streams for the three datasets are from the United States Geological Survey (USGS) National Hydrography Dataset (NHD) 1:24,000 and 1:100,000, and from the National Atlas 1:2,000,000. Mexican streams are from Instituto Nacional de Estadística Geografía e Informática (INEGI) 1:50,000, 1:250,000, and 1:1,000,000.

Borderwide Networked Hydrography

A portion of the 1:100,000/1:250,000 and 1:24,000/1:50,000 data has been refined and networked. The networked hydrography contains information regarding the location of streams on the landscape, and their connection to stream quality and quantity monitoring stations. The integration and routing of 1:24,000 and 1:50,000 data was performed by the USGS Texas Water Science Center, and the integration and routing of the 1:100,000 and 1:250,000 data was performed by the Center for Research in Water Resources (CRWR) at the University of Texas at Austin. In order to create the networked hydrography, existing, yet separate datasets for Mexico and United States hydrography were combined into one data model containing a routable network. This network provides the ability to find the path from a source (a contaminated site for example) through all of the connected streams, rivers, and water bodies to its final destination. The route allows a person to see all of the potential geographic areas that may be affected by the identified source. For this data model, the hydrographic data from Mexico was provided by the Instituto Nacional de Estadística, Geografía e Informática (INEGI), and the hydrographic data for the United States was provided by the National Hydrography Dataset (NHD) of the U.S. Geological Survey (USGS). The hydrography for Mexico used 1:50,000 scale and 1:250,000 scale data, and the hydrography for the United States used 1:24,000 scale and 1:100,000 scale data. The Center for Research in Water Resources (CRWR) at the University of Texas at Austin created the basic methodology for this data-merging procedure, which involved working refinements on the data, and then placing the data into an Environmental Systems Research Institute, Inc (ESRI) geodatabase with the CRWR ArcHydro™ schema.

Data Refinements for Networked Data

The networked datasets required certain corrections made before they could be merged into one dataset. The NHD data from the U.S. is “a feature-based dataset that interconnects and uniquely identifies the stream segments or "reaches" that make up the Nation's surface water drainage system” (USGS 1999). It also provides flow direction and centerline representations through surface water bodies. Because of the network framework of the NHD, very little additional work was needed to use this dataset. The hydrographic data from Mexico consists of line-work digitized off of 1:50,000 or 1:250,000 topographic-maps with no added connectivity. In locations where a water body or other geographic feature intersected a stream on the topographic map, a gap was left while digitizing. Also, the flow directions of the streams were not considered in the digitization process. The corrections that were necessary were completed within the personal geodatabase framework using ESRI® ArcGIS™ software. The flow direction for all stream segments had to be reviewed and corrected, if an error was found, corrected so that the digitized direction of the stream features followed the actual direction of flow in the landscape. ESRI topology rules were used to correct geometric errors within the datasets, such as lines intersecting themselves, dangles, overlapping features. All stream segments had to be continuous (i.e. they all had to be connected to one another with no gaps). Several datasets were used to assist with identifying where these connections should be made: Digital Raster Graphic (DRG) topographic maps, other existing small scale stream centerline datasets, imagery (e.g. Digital Orthophoto Quarter Quadrangles (DOQQ), Landsat satellite) and the CRWR ArcHydro toolset. Other errors that had to be corrected included: spurious area catchments, ambiguous loops (mostly caused within canal grids), and duplicity.

The Geodatabase

The CRWR ArcHydro methodology provides for two possible database models, one that is more complex, and another “Framework” model, which is the simpler of the two. For the 1:24,000/1:50,000 dataset created by the USGS Texas Water Science Center, the “Framework” model was used, because it can be added into the more complex model at a later date as more data and research have been completed. There are several feature-classes that complete the ArcHydro geodatabase: HydroEdge (the streams), HydroJunction, monitoring points, water bodies, and watersheds. At this time, the HydroEdge feature-class has been completed for this project, and the data for the other feature-classes are still being collected and analyzed. The HydroJunction is defined as a “point of strategic hydrologic interest, such as the outlet of a water body or watershed” (Maidment 2002). The monitoring points consist of a “permanent monitoring site, such as a stream gage, river gage, or climate station, or a sampling point on a stream or river where water-quality samples are periodically taken” (Maidment 2002). After the proper feature classes are added to the ArcHydro geodatabase, the Hydro Network (a geometric network tracing water movement through streams, rivers, and water bodies (Maidment 2002)) is built. A geometric network is edge elements (e.g. streams) and junction elements (e.g. point where two streams connect) connected by topology (Borchert).

Conclusion

In conclusion, the hydrographic component of the BEHI project should accommodate the ability for researchers to trace sources of public health concern via water transport from their origin to all potentially affected communities. It should provide the means to both pinpoint existing problems as well as provide the ability to predict potential threats to water systems and communities affiliated with those systems. The CRWR ArcHydro Framework provides a powerful tool for understanding the ties between water and human health. Currently, only a small portion of the hydrographic data covering the border between the United States and Mexico has been refined and networked. Our goal is to provide a routable hydrographic network for the entire border, which we will do with the assistance of collaborators.

References and Resources

Borchert, Robert (n.d.). *Geometric Network.* http://gis.esri.com/library/userconf/proc03/p0885.pdf

Border Environmental Health Website: http://borderhealth.cr.usgs.gov/

Center for Research in Water Resources (CRWR) at the University of Texas at Austin website: http://www.crwr.utexas.edu/

Instituto Nacional de Estadística, Geografía e Informática (INEGI): http://www.inegi.gob.mx/inegi/default.asp

Maidment, David R., ed. 2002. *Arc Hydro GIS for Water Resources.* NY: ESRI. http://www.crwr.utexas.edu/gis/archydrobook/ArcHydro.htm

National Atlas of the United States: http://www.nationalatlas.gov/

National Hydrography Dataset: http://nhd.usgs.gov/

North American Atlas: http://geogratis.cgdi.gc.ca/clf/en?action=northAmericanAtlas

Online Support System for the Arc Hydro Data Model: http://www.crwr.utexas.edu/giswr/hydro/ArcHOSS/index.cfm

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